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ABSTRACT

The paired-associate learning of 52 fourth graders was related to measures of cognitive ability obtained the previous year. Subjects were administered the paired-associate task under one of three variations: at a comfortable rate with standard instructions; at a comfortable rate with a potentially effective learning strategy (visual imagery); and at a speeded rate with standard instructions. As anticipated on the basis of earlier research with children of this age, the relationship between reasoning (as reflected by Raven's Progressive Matrices) and learning was augmented when subjects were supplied with the imagery strategy and diminished when the task was speeded. Negligible correlations between rote memory (as reflected by digit span) and learning were obtained under all task variations. Interpretations of the results and speculations for future research are included. (Author)

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Technical Report No. 315

COGNITIVE ABILITIES AND STRATEGIES IN CHILDREN'S PAIRED-ASSOCIATE LEARNING

by

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Report from the Project on
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Statement of Focus

Individually Guided Education (IGE) is a new comprehensive system of elementary education. The following components of the IGE system are in varying stages of development and implementation: a new organization for instruction and related administrative arrangements; a model of instructional programing for the individual student; and curriculum components in prereading, reading, mathematics, motivation, and environmental education. The development of other curriculum components, of a system for managing instruction by computer, and of instructional strategies is needed to complete the system. Continuing programmatic research is required to provide a sound knowledge base for the components under development and for improved second generation components. Finally, systematic implementation is essential so that the products will function properly in the IGE schools.

The Center plans and carries out the research, development, and implementation components of its IGE program in this sequence: (1) identify the needs and delimit the component problem area; (2) assess the possible constraints—financial resources and availability of staff; (3) formulate general plans and specific procedures for solving the problems; (4) secure and allocate human and material resources to carry out the plans; (5) provide for effective communication among personnel and efficient management of activities and resources; and (6) evaluate the effectiveness of each activity and its contribution to the total program and correct any difficulties through feedback mechanisms and appropriate management techniques.

A self-renewing system of elementary education is projected in each participating elementary school, i.e., one which is less dependent on external sources for direction and is more responsive to the needs of the children attending each particular school. In the IGE schools, Center-developed and other curriculum products compatible with the Center's instructional programing model will lead to higher student achievement and self-direction in learning and in conduct and also to higher morale and job satisfaction among educational personnel. Each developmental product makes its unique contribution to IGE as it is implemented in the schools. The various research components add to the knowledge of Center practitioners, developers, and theorists.

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Abstract

The paired-associate learning of 52 fourth graders was related to measures of cognitive ability obtained the previous year. Subjects were administered the paired-associate task under one of three variations: at a comfortable rate with standard instructions; at a comfortable rate with a potentially effective learning strategy (visual imagery); and at a speeded rate with standard instructions. As anticipated on the basis of earlier research with children of this age, the relationship between reasoning (as reflected by Raven's Progressive Matrices) and learning was augmented when subjects were supplied with the imagery strategy and diminished when the task was speeded. Negligible correlations between rote memory (as reflected by digit span) and learning were obtained under all task variations. Interpretations of the results and speculations for future research are included.

I
Introduction

We are nearing the end of the second decade since Cronbach's (1957) classic plea for a reconciliation between the correlational (individual differences) approach and the experimental (task parameter) approach to the study of human cognitive precesses. Although occasional advances have been made by those who have taken Cronbach's case seriously (e.g., Fleishman, 1972; Frederiksen, 1969), for the most part the accumulation of knowledge in this domain has been meager. Undoubtedly a partial cause is the lack of a theoretical basis for experimental investigations of seemingly reasonable hypotheses concerning which task parameters should interact with which individual difference variables and why. As has been argued previously (Labouvie, Frohring, Baltes, & Goulet, 1973), a successful cross-linkage between the two approaches demands a demonstration and understanding of such interactions.

Although Labouvie et al. (1973) were able to obtain relationships between cognitive abilities and free-recall performance which were moderated by selected task parameters, more recently Labouvie-Vief and Levin (in press) were unable to replicate the finding. In one of their experiments with seventh and twelfth graders they found that various pre-learning instructions did not affect free-recall in the manner anticipated, which may have contributed to the noneffect. Similarly, in a second experiment with third and tenth graders they found that a delay interval designed to increase conceptual activity did not affect recall, again providing a partial explanation for the resulting noneffect. Based on these findings, the authors speculated that unless the task parameters manipulated are potent and relevant to the posited cognitive processes, researchers may find themselves well down range of the relationships they are seeking, even if the associated hypotheses are plausible.

The present study provides some support for this speculation. About a year after the third graders of the previous study were administered the ability tests and the free-recall task, they were reassessed with a different learning instrument. The instrument was a paired-associate learning task which was administered under one of three variations designed to affect the degree of rote or conceptual activity demanded of the children. The paired-associate task was selected because it has previously been found to produce tremendous differences in performance as a function of variations in instructional strategies, and third graders were used because previous findings have shown that they exhibit considerable variability in performance when a paired-associate task is administered in conjunction with the strategies of interest here (see Levin, in press).

II
Method

Subjects

Of the 60 third graders from the Labouvie-Vief and Levin (in press) study, 54 could be located as fourth graders the following year, at which time their mean age was 9 years, 10 months. These children were randomly assigned in equal numbers to three instructional conditions. (Two subjects who were obviously distracted in the present learning task were dropped from the study, yielding a final total of 52 subjects).

Reasoning and Memory Tests

One year before the present study, these children had been administered tests of memory and reasoning. Since available evidence indicates that one-year stabilities of mental abilities are close to unity for subjects of this age (cf. Bloom, 1964), it was decided to use the previously obtained scores as indicators of the respective abilities. Both tests had been selected to tap the rote-conceptual dimension proposed by Jensen (1968) to mediate differences in learning-ability relationships. A digit-span test was used to assess rote memory. This test was patterned after one developed by Jensen (see Jensen & Rohwer, 1970) and utilized digit series presented in order of increasing length. Three such series were administered in a group-testing format. Subjects followed tape-recorded instructions and marked their answers in specially designed booklets. Raven's Progressive Matrices was used as a test of reasoning or conceptual ability.

Paired-Associate Task

The learning task consisted of the paired-associate recall of twelve high-frequency noun pairs. All subjects received three alternating study and test trials in which they listened to the tape-recorded nouns. On each trial, subjects were presented with a different random order (constant across subjects) of the paired associates. Subjects were tested individually in sessions lasting approximately ten minutes.

Experimental Conditions and Predictions

Three different variations of the paired-associate task were administered. In one (Standard), subjects were given standard pre-learning instructions and the items were presented at a 3-second rate (found to be a reasonable interval for children of this age). The two other conditions were designed to either decrease or increase subjects' reliance on conceptual activity, which, in terms of Jensen's (1968) continuum, should reciprocally increase or decrease their reliance on rote activity. In the Speeded condition, subjects were given standard instructions but the presentation rate was reduced from 3 seconds to 1 second; and in the Strategy condition, the 3-second rate was maintained but prior to the task subjects were instructed to imagine an interaction involving the members of the pair. Although such a strategy produces consistently high paired-associate performance in "cognitively mature" learners (e.g., Bower, 1972), it has achieved only variable success in elementary school children, especially when verbal stimulus materials are employed (see Levin, in press).

Accordingly, it was predicted that positive effects derived from the cognitive strategy could be related to differences in the subjects' conceptual abilities (as reflected by Raven performance); specifically,

a positive relationship between Raven and paired-associate performance was expected in the Strategy condition. However, such a relationship was not anticipated in the Speeded condition in which the subject's success would depend more on short-term memory, i.e., rote, rather than conceptual processes. If anything, in the Speeded condition paired-associate learning should be more highly related to digit span than to Raven performance. The relationships obtained in the Standard condition would provide a baseline against which the other two conditions could be compared.

Put simply, the present study sought to determine whether the usual paired-associate learning (Standard) of elementary school children related more to rote or to conceptual abilities, and whether the latter relationship could be either augmented or diminished as a function of experimental variations (Strategy or Speeded).

III
Results

The correlation between Raven and paired-associate performance (the latter summed over three trials) and between digit span and paired-associate performance is presented in Table 1, for each of the experimental conditions.

Two aspects of the data in Table 1 deserve emphasis: first, the stronger relationship between associative learning and Raven performance than between associative learning and digit span in the Standard condition; and second, the difference in patterns between the Strategy and Speeded conditions. The first finding underscores previous arguments that so-called "rote-learning" tasks are anything but that (see Labouvie-Vief & Levin, in press; and Rohwer & Levin, 1971). If they were, the short-term memory processes called upon in reproducing a series of digits should also be called upon in associating pairs of words, but the correlational data suggest that they are not. Rather, it appears that paired-associate learning relies on some of the reasoning and conceptual processes involved in Raven performance.

The second finding suggests that when subjects are required to employ a cognitive strategy in the learning task, the relationship with Raven performance is strong; whereas when the learning task is so speeded that such cognitive processes cannot be effectively used, the relationship disappears. Note, however, that even in this case digit span is not predictive of paired-associate learning--a lack which cannot be attributed to the unreliability of the digit-span test (see Jensen & Rohwer, 1970). Nor is the lack of relationship between Raven and paired-associate performance in the Speeded condition attributable simply to a reduced spread of learning scores in that condition. While variation in paired-associate performance was indeed largest in the Strategy condition, as expected (the range was from 8 to 35 out of 36, with a variance of 72.9), the variation in the Speeded condition (range = 0 to 19, variance = 35.3) was at least as great as that in the Standard condition (range = 6 to 24, variance = 30.6).

Following Labouvie-Vief and Levin (in press), the learning data were further analyzed. In the earlier study, these same subjects were classified as high or low ability, based on their scoring above or below the median on

TABLE 1

Learning-Ability Correlations by Experimental Condition

Ability	Condition		
	Standard (N=17)	Strategy (N=17)	Speeded (N=18)
Raven	.453*	.462*	.083
Digit Span	.011	.274	-.360

* $p < .05$, one-tailed

the Raven and digit-span tests. Using the previous high-low classifications and the present experimental conditions as factors, multivariate analyses of variance were performed on the paired-associate data (with the three trials comprising a repeated measure). Two such analyses were conducted, one based on Raven classifications and the other on digit-span classifications.

Table 2 lists mean paired-associate performance across trials according to ability classifications and experimental conditions. The analysis of variance indicates that treatment-related variation was indeed produced ($p < .001$)--unlike the Labouvie-Vief and Levin (in press) outcome--with the performance of Strategy subjects highest (mean = 20.24), that of Standard subjects intermediate (11.94), and that of Speeded subjects lowest (7.94).

Concerning the major hypothesis, when high and low Raven classifications were compared within each treatment condition it was found that, according to predictions, the largest difference occurred in the Strategy condition ($p < .05$, one-tailed), a difference of about 5 1/2 items (see Table 2). This difference is reduced to about 2 1/2 items in the Standard condition and about 1 1/2 items in the Speeded condition, neither a significant classification effect.

Consistent with the correlational data, no significant differences due to digit-span classifications were detected. Although substantial improvement occurred across trials in all conditions ($p < .001$), no interactions involving trials were produced.

TABLE 2

Mean Paired-Associate Performance, as a Function of Ability Classifications and Experimental Conditions

Ability	Standard		Strategy		Speeded	
	High	Low	High	Low	High	Low
Raven	13.50	11.09	23.12	17.67	8.86	7.36
Digit Span	10.83	12.54	22.75	18.00	6.54	10.14

IV
Discussion

The present experiment provides support for our earlier assertion that differentiated learning-ability relationships can be detected and exploited if the underlying processes tapped by measures of learning and ability are well understood, or at least analyzed with greater care than has typically been the case. Unlike our previous investigation in which the experimental manipulations produced negligible effects (Labouvie-Vief & Levin, in press), the manipulations employed here were highly successful in affecting the level of paired-associate performance. As expected, the associated correlation between Raven and learning varied considerably across experimental conditions. Although the correlational results reveal significant relationships between Raven and paired-associate performance in both the Standard and Strategy conditions (Table 1), additional analysis suggests that high and low Raven scorers differ in paired-associate learning more when they are required to employ a cognitive strategy than when they are left to their own devices (Table 2).

This result is especially informative when compared to previous research findings which demonstrate large individual differences in the ability of children at this age to employ an imagery strategy successfully (see Levin, in press). The present data indicate that the children who benefit most from such a strategy are those with high reasoning ability as determined from Raven's Progressive Matrices test (see also Levin, 1973; and Levin, Divine-Hawkins, Kerst, and Guttmann, 1974, for other individual difference variables related to the ability to profit from visual imagery). While there is some relationship between reasoning and paired-associate learning when these children are administered the task without strategy instructions, (which exceeds the short-term memory/paired-associate learning relationship--See Table 1) the two analyses suggest that it is not as pronounced. It would be interesting to determine whether this relationship can be augmented by using adolescent subjects, since subjects of that age tend to benefit more uniformly from mediational strategies and are likely to be differentiated most on their propensity to employ such strategies spontaneously (see Rohwer, 1973).

The failure of digit span (a short-term memory test) to be predictive of the paired-associate learning of high-frequency nouns is also interesting. First, this finding replicates the free-recall results of Labouvie-Vief and Levin (in press) and further highlights the process differences in ostensibly similar tasks. In particular, although both the digit-span and paired-associate tasks seem to demand the rote learning of aurally presented materials, they may be hypothesized to differ in terms of the extent to which transformations of the incoming stimuli would be beneficial. With digit span it would behoove the learner to rely on those short-term memory processes that function as a tape recording of an unrelated sequence of numbers. With paired-associate learning, however, the learner would do well to form meaningful associations in long-term memory rather than to rely on a "tape recording," expecially when it is known that the test stimuli will be presented in a different serial order. Perhaps if digits or low-meaningful materials were used in a constant serial order from trial to trial, rendering the paired-associate task even more rote-like than in the present Speeded condition, this picture would change.

Finally it is possible that the differentiation of abilities in terms of their demands on simultaneous, as opposed to successive, information processing (e.g., Luria, 1966, cited in Das, 1973; Paivio, 1971) may ultimately prove more successful than the Jensen (1968) rote-conceptual distinction that was

adopted here. Indeed, interpreting Raven performance in terms of a simultaneous <u>visualization</u> factor (Das, 1973) is highly satisfying when considered in conjunction with the variability produced by the present visual imagery strategy.

References

Bloom, B. S. Stability and change in human characteristics. New York: John Wiley & Sons, 1964.

Bower, G. H. Mental imagery and associative learning. In L. Gregg (Ed.), Cognition in learning and memory. New York: John Wiley & Sons, 1972.

Cronbach, L. J. The two disciplines of scientific psychology. American Psychologist, 1957, 12, 671-679.

Das, J. P. Structure of cognitive abilities: Evidence for simultaneous and successive processing. Journal of Educational Psychology, 1973, 65, 103-108.

Fleishman, E. A. On the relation between abilities, learning, and human performance. American Psychologist, 1972, 27, 1017-1032.

Frederiksen, C. H. Abilities, transfer, and information retrieval in verbal learning. Multivariate Behavioral Research Monographs, 1969, No. 2.

Jensen, A. R. Another look at culture-fair tests. In Western Regional Conference on Testing Problems, Proceedings for 1968, "Measurement for Educational Planning." Berkeley, California: Educational Testing Service, Western Office, 1968. Pp. 50-104.

Jensen, A. R. & Rohwer, W. D., Jr. (Eds.). An analysis of learning abilities in culturally disadvantaged children. Final Report, Office of Economic Opportunity, Contract No. OEO 2404, 1970.

Labouvie, G. V., Frohring, W. R., Baltes, P. B., & Goulet, L. R. Changing relationship between recall performance and abilities as a function of stage of learning and timing of recall. Journal of Educational Psychology, 1973, 64, 191-198.

Labouvie-Vief, G. & Levin, J. R. The relationship between recall performance and abilities: A second look. Technical Report No. 314. Madison: Wisconsin Research and Development Center for Cognitive Learning, in press.

Levin, J. R. What have we learned about maximizing what children learn? Theoretical Paper No. 49. Madison: Wisconsin Research and Development Center for Cognitive Learning, in press.

Levin, J. R. Inducing comprehension in poor readers: A test of a recent model. Journal of Educational Psychology, 1973, 65, 19-24.

Levin, J. R., Divine-Hawkins, P., Kerst, S., & Guttmann, J. Individual differences in learning from pictures and words: The development and application of an instrument. Journal of Educational Psychology, 1974, 66, 296-303.

Luria, A. R. Human brain and psychological processes. New York: Harper & Row, 1966.

Paivio, A. Imagery and verbal processes. New York: Holt & Co., 1971.

Rohwer, W. D., Jr. Elaboration and learning in childhood and adolescence. In H. W. Reese (Ed.), Advances in child development and behavior. New York: Academic Press, 1973.

Rohwer, W. D., Jr. & Levin, J. R. Elaboration preferences and differences in learning proficiency. In J. Hellmuth (Ed.), Cognitive studies, Vol. 2. New York: Brunner/Mazel, 1971.

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